PIERRE
AUGER
OBSERVATORY

PIERRE AUGER OBSERVATORY

QUALITY ASSURANCE PLAN

Approved, Auger Project Manager	24-OCT-00 Date
Approved, Auger Systems Engineer	02 NOV 00 Date
Approved, Auger Quality Assurance Manager	10/24/00 Date

1.0 Purpose

The Pierre Auger Project is a broadly based international effort to make a detailed study of cosmic rays at the highest energies. Two air shower detectors are proposed, one to be placed in the Northern Hemisphere and one in the Southern Hemisphere. Each installation will consist of an array of about 1600 particle detectors spread over 3000 km^2. Each installation will also have three or more atmospheric fluorescence detectors viewing the volume above the surface array. These two air shower detector techniques working together form a powerful instrument for the proposed research. The objectives of the Pierre Auger Project are to measure the arrival direction, energy, and mass composition of 90 events per year above an energy of 10^{20} eV and 9000 events per year above 10^{19} eV. A collaboration has been formed and preferred sites chosen. The Southern observatory located Mendoza Argentina will be constructed first. The Northern observatory located in Millard County Utah will be started in about 2003. The goal is to have the Southern observatory in operation by 2003 and the Northern observatory in operation by 2006.

The purpose of this Quality Assurance Plan is to describe the policies and procedures for assuring the performance and reliability of the detector systems for the Pierre Auger Observatory. This document is formatted using the guidelines defined by ISO9001:1994.

2.0 Scope

The description and requirements in this plan are generally applicable to all activities included in the Auger Project, with the exception of software. More detailed descriptions regarding quality assurance for each project task are documented in the Task Quality Plans.

3.0 Related Documents

The following documents are referenced in this QA Plan:

- Project Management Plan (PMP)
- Technical Design Report (TDR)
- Performance Requirements and Technical Specifications
- Work Breakdown Structure (WBS)
- Auger Site Safety Plan
- Conventions for the Pierre Auger Observatory

These documents are available from http://www.auger.org/admin under "Project Management".

4.1 Management Responsibility

4.1.1 Policy & Objectives

The policy of the Auger Project is to develop and maintain a documented quality program so that the Project may fulfill the stated requirements, as defined in the Project Management Plan and associated documents.

The objectives, goals and functional responsibilities for the Project are defined in other Project documents, and so they are not repeated here. Specifically, information can be found in:

- Project Management Plan
- Technical Design Report
- Performance Requirements and Technical Specifications
- Work Breakdown Structure

4.1.2 Organization Structure

The organizational structure of the Auger Project is defined and documented in sections 2.1 and 2.2 of the Project Management Plan.

Clear and frequent communication is always encouraged among the project participants, and is critical to the success of the Auger Project. Informal communication via technical notes, phone conferences, electronic mail, www pages, and informal discussions are exchanged frequently between the participants. *The World Wide Web is the principle tool for communicating within the collaboration*. The Internet allows the entire collaboration to have access to pertinent information at any time, and from almost any location in the world. The main Auger web page is http://www.auger.org/admin. This site includes most Project documents (e.g. GAP notes, e-mail archives, project management plan, WBS, quality assurance plan, technical design report) and is the main portal used to share information regarding the Project to the collaboration. Also, the use of "mail lists" allows for messages to be sent to the entire collaboration, or a specific Task Group.

The flow of information made possible by the web encourages the exploration of the viability of plans and solutions, and allows for the resolution of any issues that arise.

4.1.2.1 Roles, Responsibility, and Authority

The roles, responsibilities, and authorities of personnel participating in the Auger Project are defined and documented in section 2.3 of the Project Management Plan.

4.2 Quality System

4.2.1 Policy

It is the policy of the Auger Project to establish and maintain a quality system as a tool to ensure that the Observatory conforms to the performance requirements and achieves its performance objectives.

4.2.2 Quality System Procedures

It is the responsibility of the Project Manager and the Quality Assurance Manager to define and document the overall quality assurance program for the Project. It is the responsibility of the Task Leaders to define and document the quality assurance program for their specific tasks. The Task plans should include the following:

- Overall QA Plan - text, based on ISO9001
- Flowchart - production/fabrication process
- Failure modes analysis - production/fabrication process
- Control plan - production/fabrication process
- Operator training requirements- included in overall QA Plan
- Necessary work instructions - included in overall QA Plan

Guidance on the creation of the Task QA Plans is found in the file "QA Planning Guidance", located on the main Auger web site. Training and help with the creation of the Task QA Plans is also available from the Quality Assurance Manager.

4.2.3 Quality Planning

In order to ensure the quality of the Observatory, quality is planned into the project at every step. The overall planning of quality proceeds as follows (the items in this list are completed chronologically; however, some items will be worked on in tandem - "simultaneous engineering", and project changes/feedback-loops may lead to the reiteration of this process):

Task Name	Responsible Group	Output
Scientific Objectives	Collaboration	Design Report, PMP, Tasks, Initial WBS
Requirements and Specifications	Task Leaders	Intitial Performance Req's and Tech. Spec's
Review	Collaboration	Approved PR&TS
Preliminary Design	Task Leaders	Initial TDR, Initial QA Plan, Updated WBS
Review - Design	Collaboration	Baseline TDR
Final Design	Task Leaders	Updated design, updated QA Plan, updated WBS
Review - Design & Production Readiness	Collaboration	Design Approval, Production Approval
Production/Installation	Collaboration	Observatory

4.3 Contract Review

4.3.1 Policy

It is the policy of the Auger Project to ensure that contracts made with participating institutions are defined properly so that the objectives of the Project can be met.

4.3.2 Specifics

The formal contract between the Auger Collaboration and the participating institutions is the Memorandum of Understanding (MOU). This document details the scope of work, deliverables, the level of contribution to the common fund, the work schedule, and funding arrangements. More details regarding MOU's are located in section 2.1.5 of the Project Management Plan.

For institutions that have signed an MOU, an Amendment to the MOU is issued and approved as needed. This amendment defines the changes to requirements, resources, and deliverables for the collaborating institution.

The Project Management Office maintains signed MOU's and Amendments.

Note: In the language of ISO9000, the "supplier" is the Task Group, and the "customer" is the Auger Collaboration.

4.4 Design

4.4.1 Policy

The policy of the Auger Project is to ensure that designs perform as intended. This is accomplished by incorporating sound engineering/scientific principles and appropriate technical standards into designs.

4.4.2 Design and Development Planning

Each Task Group of the Project has a plan that describes the activities associated with the Task, and defines the responsibility for the implementation of the activities. Based on the Project Management Plan and the Work Breakdown Structure, each Task Leader is responsible for planning the activities associated with their task(s).

4.4.3 Organizational Interface

Although the Auger Project Management office is based at Fermilab, the Auger Project is a collaboration of at least 250 people from approximately 19 countries and 51 institutions. In order for the Project to be successful, each Task Group must interface with the other groups. The collaboration is governed by the Auger Collaboration Board, and the details of the Collaboration Board are defined and documented in section 2.6 of the Project Management Plan.

Furthermore, Memorandums of Understanding (MOU) define the resources, responsibilities and deliverables of the collaborating institutions. The Project Management Office maintains these documents (see section 4.3 of this document).

4.4.4 Design Input

Design inputs are defined by the Task Groups, and are documented in the Performance Requirements and Technical Specifications document. These requirements are based on the Design Report and the experience/knowledge of the members of the Task Groups. The design inputs are reviewed and approved by formal design reviews before they are used to manufacture the detector systems.

4.4.5 Design Output

The Technical Design Report, and the subsequent drawings, are the outputs of the design process, and constitute the baseline design configuration. Although the Project Systems Engineer is the owner of the TDR, it is the responsibility of the Task Leaders to create the information that is recorded in the TDR. This information contains (or makes reference to) performance requirements (i.e. verifiable criteria). These documents go through formal design reviews before they are approved. The review includes verifying them against the design inputs.

4.4.6 Design Review

At appropriate stages of design, formal documented reviews of the design results are planned and conducted. Participants at each review include representatives of all functions concerned with the design stage being reviewed, as well as other qualified personnel (this may include outside experts and ES&H). These reviews are completed in order to:

1) Identify potential problem areas or inadequacies;
2) Assess issues affecting safety and quality;
3) Initiate corrective/preventive actions;
4) Ensure that the design minimizes ES&H impact and satisfies all ES&H policies and external codes.

Results from the reviews are used as a basis for verifying that design stage outputs meet the design stage input requirements.

Preliminary Design Reviews:

The Task Leaders organize the presentations for Preliminary Design Reviews, which are expected to include:

- Presentation of the design requirements
- Details of the baseline design
- Difficult tasks and technical risks
- Interface with the other subsystems and plans for integration
- Plans for prototype deployment and field tests
- Quality Assurance Plan
- Safety and environmental hazards
- Review of cost estimates
- Schedule and milestones
- Organization and resources

The reviewers should try to answer the following questions:

- Is the preliminary design complete and does it meet the design requirements?
- Are there any outstanding technical risks?
- Is any further R&D required?
- Are there more cost effective or reliable options to be considered?
- Is the cost likely to be contained within the cost estimate?
- Is the schedule for design and production achievable and consistent with the overall project schedule?

- Is the organization in place able to carry out the Task responsibilities?
- Are the resources allocated to design and production adequate?
- Is the subsystem ready to proceed with the final design? If it is not, make recommendations for achieving an acceptable preliminary design.

Critical Design Reviews:

Critical Design Reviews are conducted to ensure that the design and the fabrication process will meet the performance requirements. These reviews should utilize a tool such as "Value Engineering" to aid in determining if all factors have been included in the design and fabrication process, and determine if there are ways to improve upon the quality, efficiency and cost of the item.

More details on Critical Design Reviews will be defined and documented prior to the occurrence of the reviews.

4.4.7 Design Verification

Design verification is normally done through design reviews, however other methods may also be used. These methods include, but are not limited to:

- performing alternative calculations
- comparing the new design with a similar proven design
- undertaking tests and demonstrations

4.4.8 Design Validation

Designs are validated through the testing of the complete prototype system (or subsystem) during and after assembly, against the performance requirements. The final validation of the design is completed with the Engineering Array.

4.4.9 Design Changes

Appropriate design controls are incorporated into the project by using configuration management. The Configuration Control Board (CCB) controls design changes (see section 8 of the Project Management Plan for details of the CCB).

All design changes that are proposed by the Task Leaders go through a formal design review. In order for the new design to be approved, the Task Leader must convincingly demonstrate to the review board that either the old design is not adequate, or that the new design has superior performance and/or cost advantage(s) over the old.

4.5 Document and Data Control

4.5.1 Policy

The policy of the Auger Project is to maintain adequate documentation and data to ensure that the quality requirements are met, while recognizing the objective of minimizing paperwork and cost.

4.5.2 Document and Data Approval and Issue

Controlled documents and data are created, implemented, and maintained at a level commensurate with the level of work being performed. In general, each Task Group is responsible for controlling the documents and data that relate to the tasks under their domain. Controlled documents and data are reviewed approved by authorized personnel prior to issue, and authorized personnel are defined for each document that is controlled.

The Auger Project maintains the following documents under document control (authorized personnel are defined in parenthesis):

- Auger Project Quality Assurance Plan (QA Manager, Project Manager)
- Task Quality Assurance Plans (QA Manager, Project Manager, Task Leaders)
- Released engineering drawings (Task Leaders, Systems Engineer)
- Procurement specifications (Task Leaders, Systems Engineer)
- Performance Requirements and Technical Specifications (Task Leaders)
- Project Management Plan (Project Manager)
- Cost Estimate (WBS) (Project Manager, Cost and Schedule Officer, Systems Engineer, Task Leaders)
- Integrated Project Schedule (Project Manager, C&S Officer)
- Operations Plan (Systems Engineer, Site Manager)
- MOU's (Project Manager, Spokesperson)
- Site Safety Plan (Environmental, Safety and Health Officer, Site Manager)

The Task Leaders are responsible for the control of documents and data pertaining to engineering specifications, engineering procedures, and preliminary drawings; and for the control of documents and data regarding detector assembly and testing.

The Task Leaders are also responsible for the control of documents and data associated with the procurement of materials for their Task.

4.5.3 Document and Data Changes

All controlled documents:

1. Are reviewed and approved by authorized personnel prior to being issued/revised.
2. Have a revision history maintained.
3. Are available to all personnel who need access.

Section 9 of the Project Management Plan contains more detail on document control for the Project.

4.6 Purchasing

4.6.1 Policy

The policy of the Auger Project is to conduct all procurement activities such that all applicable ES&H and quality requirements are fulfilled.

Due to the fact that the Auger Project is composed of institutions from around the world, minimal procurement requirements are stated in this document. However, each Task Leader is responsible for understanding and following the applicable procurement standards/methods for the parts/services being procured for the task, so that all applicable ES&H and quality requirements are fulfilled. At minimum, hazard analysis and Material Safety Data Sheets (MSDS) are used in the procurement process. More details regarding this topic or described in the Auger Site Safety Plan.

4.6.2 Evaluation of Subcontractors

Task Leaders are responsible for selecting subcontractors on the basis of their ability to meet subcontract requirements. These requirements are appropriately defined and documented by the Task Groups, and include specific quality assurance requirements.

The following lists criteria that should be used to evaluate subcontractors. This is not an exhaustive list, but serves to provide Task Groups with guidance.

- Ability/cost to service
- Financial history
- Quality/ES&H System status
- References/credentials
- Ability to meet Certificate of Analysis & Statistical Quality/Process Control requirements
- Ability to meet procurement specifications
- Pricing (including applicable freight and packaging costs)
- Ability to meet all applicable regulatory requirements
- First, second or third party audits &/or inspection/testing results
- Control Plan and Failure Modes & Effects Analysis for the product
- Manufacturing capacity & the ability to meet all order/delivery requirements

Task Leaders are also responsible for creating and implementing a system to conduct ongoing evaluation of suppliers. This includes defining performance criteria for these suppliers. The supplier is evaluated against these criteria, and if quality problems are identified then they are recorded and reported to the appropriate personnel. The responsible authority for the area or activity in which they will be used reviews these reports, and a disposition will be made, e.g. reject, rework in-house, rework at vendor, return for replacement, or use as is. These

reports are reviewed for repetitive supplier performance problems or trends, and are used as a basis for cause analysis and continuous improvement.

4.6.3 Purchasing Data

Each Task Group is responsible for ensuring the integrity of their purchasing data and documents. This means that purchasing documents should clearly describe the deliverables that are expected from the subcontractor (this could include data, parts, service, etc.). As applicable, the description should include or reference a part number, specification, and/or drawing, as well as any other requirements that have been defined by the Task Group.

4.8 Identification and Traceability

4.8.1 Policy

It is the policy of the Auger Project to use proper identification and traceability methods in order to ensure that the history of the detectors (and their components) is known, or otherwise easily determined.

4.8.2 Specifics

To allow for identification and traceability, Task Leaders are responsible for developing and implementing a system to record and track batch, lot, and serial numbers for parts/components that are used to make the detectors. The information recorded also includes inspection and testing results (see section 4.10 of this QA Plan). This system should be planned and implemented with the goal of easily being able to trace a detector's history. This could be used for times when a component either functions exceptionally well or very poorly, and it is necessary to determine the origins and characteristics of the component in question.

The use of "Travelers" is one example of how this can be accomplished. A Traveler is a document (either hard copy or electronic) that is used to define the method of fabrication for a component, as well as a record that contains the batch/serial numbers of the parts that were used to make the component.

More information regarding identification and traceability can be found in the document entitled *Conventions for the Pierre Auger Observatory*.

4.9 Process Control

4.9.1 Policy

The policy of the Auger Project is that production processes be properly planned, appropriately documented and reviewed, and that they be carried out under controlled conditions.

4.9.2 Specifics

The Task Leaders are responsible for ensuring that production processes are carried out under controlled conditions. When planning the production processes, the following are considered:

- All applicable government safety and environmental regulations
- Use of "Work Instructions" to document the methods of production. These should be used when the absence of such procedures could be adverse to quality.
- Defining suitable equipment and work environment to ensure quality.
- Defining suitable maintenance of equipment to ensure continuing process capability.
- Defining the criteria for workmanship in the clearest practical manner. Examples of this are work instructions that document tolerances for process parameters, samples or pictures of "quality" product, samples or pictures of poor quality or failure modes to look for.
- Level of education and experience required for production operators.
- Training needs for production operators

No matter how well a process has been planned, it is likely that there are ways that it might be improved. When planning the production process, scientists and engineers are encouraged to use "Value Engineering" to aid in determining what areas could be improved. Value Engineering should also be used during Critical Design Reviews (see section 4.4.6).

Although the collaboration scientists and engineers are responsible for quality planning, the line worker is the first line in ensuring quality. They are responsible for following the procedures that define the assembly and quality control checks in the fabrication of the detectors, e.g. Quality Control Travelers. They also have the authority to report any possible nonconformities to management, and may participate in cause analysis and continuous improvement (see section 4.14).

4.9.3 Defect Prevention

Although defect detection, i.e. quality control testing, is needed to ensure that defects do not make it into the field, it is the intent of Auger Project Management to utilize defect prevention tools to prevent defects from occurring. To this end the Project Manager and Quality Assurance Manager recommend the use of the following tools. Training and help with the implementation in the use of any of these tools is available from the Quality Assurance Manager.

- Traveler – a traveler (often referred to as "Quality Control Traveler", or QCT) is a tool that is the combination of a detailed work instruction, a quality control checklist, and a record of product traceability. It is the primary document that the line worker uses to fabricate and test the product.
- Flowcharting – flowcharting is an excellent method for defining the sequence of the fabrication process, and allows an individual or group to identify potential problem areas in the process. Flowcharting is also an excellent way to train operators on the fabrication process.
- Failure Modes and Effects Analysis – FMEA is a tool that is commonly used in the automotive and aerospace industries. Its purpose is to aid a group in identifying and minimizing potential failure modes in both the design and the fabrication process.
- Control Planning – Control plans can be seen as a combination of flowcharting and FMEA. They show the sequence of the fabrication process, and incorporate “control points” which aid in the verification of the level of quality of the product.
- Statistical Methods – as scientists, we use statistics to analyze experimental data. Tools such as Statistical Quality Control (SQC) and Statistical Process Control (SPC) aid in determining the level of quality (including consistency) of incoming parts and the fabrication process. They can aid in seeing a potential problem before it happens, or at least before it goes to the next step in the process. Pareto diagramming is also an excellent tool for identifying areas that need improvement. When faced with a range of issues that could be improved, Pareto diagramming aids in determining which issues should provide the greatest benefit (if corrected) by graphically showing the "vital few versus the trivial many".

A graded approach is used to implement quality assurance; the appropriate tools are chosen depending on the complexity of the manufacturing process, the level of expertise of the operators, the level of quality desired, and funding.

4.10 Inspection and Testing

4.10.1 Policy

The policy of the Auger Project is to ensure that all items, components, and services meet the technical specifications. This is verified through the use of inspection and testing.

4.10.2 Specifics

The Auger Project Manager and the Task Leaders define the types of work that require formal inspections and acceptance testing. Inspection and testing are performed in accordance with proper training and/or written procedures. When an inspection or acceptance test is performed, the characteristics and processes to be inspected or tested, the inspection techniques to be used, the hold points, and the acceptance criteria are defined, as appropriate.

Receiving Inspection

Each Task Group is responsible for defining and documenting (in the Task QA Plan) the appropriate receiving inspection. Incoming product is not used until it has been inspected or otherwise verified as conforming to technical specifications (except under "positive recall" procedures - see below). Task Groups should consider the following when planning receiving inspection:

- Receipt of statistical data
- Sampling based on previous performance
- Second or third party audits of subcontractor facilities
- Part evaluation by accredited contractors or test laboratory
- Subcontractor warrants (should include actual test results)

Receiving inspection is also done at the Observatory site on detector components and subsystems. The Site Manager should consult with the Task Leaders when planning the appropriate receiving inspection at the Observatory.

In-Process Inspection

Each Task Group is responsible for defining and documenting (in the Task QA Plan) the appropriate in-process inspection. In-process product is not processed further until it has been inspected or otherwise verified as conforming to technical specifications (except under "positive recall" procedures - see below). Task Groups should consider the use of defect prevention techniques when planning in-process inspection (see section 4.9.3 Defect Prevention).

Final Inspection

Each Task Group is responsible for defining and documenting (in the Task QA Plan) the appropriate final inspection. Final product is not shipped until it has been inspected or otherwise verified as conforming to technical specifications (except under concession from the Configuration Control Board - see 4.13 Control of Nonconforming Product). Final inspection should include the confirmation that all receiving and in-process inspections have been completed, and that the results meet the technical specifications.

Positive Recall

When product is released for urgent production use prior to verification, it is positively identified so as to permit immediate recall if necessary (this is termed "positive recall"). The Task Leader is responsible for determining when the use of unverified product warrants the review of the Configuration Control Board.

Note: Positive recall is used when product has *not been verified* against specification, but is going to be used in production. If product has been inspected and is found to be *nonconforming* (i.e. does not meet the technical specification) then Control of Nonconforming Product applies (see section 4.13).

4.10.3 Records

To allow for traceability, adequate records are maintained for all inspections and tests. These records include observations made, inspection/test results, identification of the personnel conducting the inspection/test, date, and time.

4.11 Control of Inspection, Measuring and Test Equipment

4.11.1 Policy

The policy of the Auger Project is to use properly calibrated and maintained measuring and test equipment for all testing.

4.11.2 Specifics

During the planning for the control of test equipment, the Task Leader takes the following under consideration:

- Determining the measurements to be made and the accuracy required, and selecting the appropriate test equipment that is capable of the necessary accuracy and precision.
- Identifying all test equipment that can affect product quality, and calibrate at prescribed intervals, or prior to use, against certified equipment (i.e. traceable to NIST or other national/international standards organization).
- Defining, and documenting as appropriate, the methods used for calibrating test equipment.
- Identifying test equipment calibration status appropriately.
- Ensuring that the environmental conditions are suitable for the tests being carried out.
- Ensuring that the handling, preservation, and storage of test equipment is such that the accuracy and fitness for use is maintained. This includes preventing adjustments to test equipment that would invalidate the calibration setting.
- Assessing and documenting the validity or previous test results when test equipment is found to be out of calibration.

Although not a requirement, it is recommended that Gage Repeatability and Reproducibility studies be conducted on critical test equipment. These studies quantify the variation that is inherent in the measurement process, and help in determining the suitability of the measurement process for the intended purpose.

4.12 Inspection and Test Status

4.12.1 Policy

It is the policy of the Auger Project to clearly identify the test status of all raw, intermediate, and final products, and indicate whether or not they have been approved for further processing.

4.12.2 Specifics

Task Leaders are responsible for defining and implementing a system for the identification of the test status of the detector components of their Task. The goal of the system is to ensure that only product that has passed the required inspections and tests (or is released under "authorized concession" - see section 4.13) is dispatched, used, or processed further.

4.13 Control of Nonconforming Product

4.13.1 Policy

It is the policy of the Auger Project to control nonconforming product such that it is not inadvertently used in the fabrication of the detectors.

4.13.2 Specifics

Task Leaders are responsible for defining and implementing a nonconforming product control system that is applicable to their Task. This system includes the identification, documentation, evaluation, segregation (where practical), and disposition of nonconforming product. After reviewing the nonconforming product, it may be:

- Reworked to meet the specified requirements;
- Accepted with or without repair by concession;
- Rejected.

The Task Leader is responsible for ensuring that repaired/reworked product is reinspected according to the Task QA Plan.

When nonconforming product is accepted without repair, and is used in the manufacturing of the detectors, then the Task Leader is responsible for notifying the Systems Engineer of the situation. This communication allows the Systems Engineer to notify other Task Leaders that may potentially be effected by the nonconforming product. The Task Leaders are also responsible for determining when the use of nonconforming product warrants the review of the Configuration Control Board. The Task Leaders should consider the following when making this decision:

- The criticality of the characteristic(s) of the part that is out of specification
- How far the part is out of specification
- The criticality of the part in the detector subsystem
- The potential risk of failure of the detector subsystem due to the nonconforming part
- The effect of the nonconforming part on other detector subsystems
- The effect of the nonconforming part on the science objectives

4.14 Corrective and Preventive Action

4.14.1 Policy

The policy of the Auger Project is to continuously improve in all areas and activities.

4.14.2 Responsibilities

- All personnel performing a function for the Project are responsible for quality and are encouraged to promptly report conditions adverse to quality such as deviations, deficiencies, failures, defective items or processes, and nonconformances, to the appropriate level of management.
- Personnel closest to the daily operation or activity are in the best position to understand and report nonconforming conditions, and are encouraged to participate in quality improvements to achieve the objectives of the project mission.
- Strong emphasis is placed on line supervision leadership, accountability, and the implementation of quality tools at the line level.
- Management is responsible for providing the necessary resources for conducting root cause analysis and for implementing corrective and preventive actions.
- Task Leaders are responsible for the development and maintenance of their own corrective/preventive action system.

4.14.3 Specifics

For the Auger Project, *corrective action* is defined as an action taken to correct something that has already gone wrong, and *preventive action* is defined as an action taken to prevent something from ever occurring. In both cases, the goal is to find the root cause for the problem (or potential problem) and to eliminate it so that it doesn't happen again (or it doesn't ever occur). *Root cause* is defined as the most basic reason for something to occur.

Although each Task Leader is responsible for the development and maintenance of their own corrective/preventive action system, all systems have the following characteristics:

- When the cause for the problem is not inherently obvious, an investigation is conducted to determine the root cause. This investigation can be done by an individual or by a cross-functional group of people. The magnitude of the investigation is appropriate for the magnitude of the problem.
- Corrective/preventive actions are taken to the degree appropriate for the magnitude of the problem. The actions taken eliminate the root cause from occurring again.

- Verification is done to confirm that the corrective/preventive actions are complete and that they are likely to be effective.
- Follow-up is done (usually 3-6 months after actions are completed) to determine if the corrective/preventive actions were effective in eliminating the root cause.

Training and help with the implementation in the use of root cause analysis techniques and corrective/preventive action programs is available from the Quality Assurance Manager.

4.15 Handling, Storage, Packaging, Preservation and Delivery

4.15.1 Policy

It is the policy of the Auger Project to ensure that the storage and handling of the detector components is done in a way that ensures the quality objectives of the array.

4.15.2 Specifics

Because the Project consists of collaborating institutions from around the world, detector components will be packaged, stored, and shipped across the globe. This means that it is very important to properly plan and implement systems that ensure that the quality of the components is maintained - a component that was "good when it left the plant" does no good if it arrives broken in Argentina and Utah.

The Task Leaders are responsible for defining and implementing a system of storage and handling to ensure that the detector components do not get damaged or deteriorate. The scope of this system is from the receipt of the sub-components to the delivery of the components to their destination (it is the responsibility of the subcontractor to ensure that sub-components arrive without damage). This means that it is the responsibility of the Task Leaders to ensure the quality of the components during:

- the handling at their site (i.e. receiving and processing);
- the packaging of the components for storage and shipment;
- the transit to the "customer".

The packaging of the components needs to prevent the part from damage and deterioration, as well as allow the component to be easily identified.

Task Leaders are responsible for defining and documenting how the Site Manager should handle and store the detector components at the Observatory site. The Task Leader is also responsible for ensuring that the Site Manager receives the proper documentation/training on these handling methods.

It is the responsibility of the Site Manager to handle and store the detector components according to the instructions provided by the Task Leaders. Site Managers are also responsible for ensuring that the site personnel receive the appropriate training on the handling of the detector components.

4.16 Control of Quality Records

4.16.1 Policy

The policy of the Auger Project is to maintain adequate records to ensure quality requirements are met, while recognizing the objective of maintaining the appropriate records for scientific and historical purposes.

4.16.2 Specifics

The Auger records management program will be defined and implemented after the southern array is operating. At that time, Project Management will determine the records and data that will be maintained as "official" Auger Project information.

The program will address the following requirements:

- Project records are to be legible and stored in a way that allows for them to be easily retrieved.
- Storage facilities must provide a suitable environment to prevent damage, deterioration, or loss.
- As appropriate, project records will be made available to the public (the preferred method is to use the Internet to disseminate information).

4.17 Assessment

4.17.1 Policy

The policy of the Auger Project is to regularly assess the Project's effectiveness in meeting it's objectives, goals, and compliance to orders and regulations. This is accomplished using self-assessments.

4.17.2 Specifics

Project management will evaluate the collaborating organization's role in the Auger Project, in order to ensure each group's continuing suitability in fulfilling the requirements of the Auger Project, and to help foster continuous improvement.

Assessments are made using formal and informal meetings and other communications. Examples are:

- Project Management meeting with Task Leaders and other project personnel
- Task Group meetings
- Suggestions and recommendations from project personnel
- Design reviews
- Collaboration meetings
- Internal Quality Audits
- Configuration Audits - functional (documentation) and physical (product)
- Third-party audits (e.g. funding agencies)

Also, a special management oversight committee with be assembled consisting of representatives from the Department of Energy, the National Science Foundation and consultants.

4.17.3 Feedback

Information gathered during management assessments is used to provide feedback to the Auger Project personnel. This information will allow project personnel to make improvements and any necessary corrective/preventive actions, so that the goals of the Auger Project may be met.

4.18 Training and Qualifications

4.18.1 Policy

The policy of the Auger Project is to hire and maintain personnel, at the institution and at the site, who posses the appropriate level of skill, experience, and academic qualifications to support the achievement of the Project's mission.

4.18.2 Training

Training is an excellent tool that aids in the prevention of defects, and therefor it will be used throughout the life of the Auger Project. Specifically, the proper training of assembly personnel is critical to the quality objectives of the Project. It is the responsibility of the Task Leaders to define and document the training needs for the people working on their tasks as well as for the site personnel who will be operating the array. It is the responsibility of the Site Managers to ensure that the site personnel receive the proper training on the operation of the array (this includes initial as well as on-going training).

- Training is provided to ensure that an appropriate level of skills, knowledge, expertise, and experience are available to accomplish the stated mission and subordinate objectives.
- Training may come from several sources such as mentoring provided by physicists, engineers, supervisors, lead personnel, consulting firms, technical operating manuals, and other sources.
- Training records of all assigned personnel, for work related to the Auger Project, are maintained by the respective supporting organization.
- Functional responsibilities, job descriptions, and specific job training requirements are contained in the respective organization quality plans (or other appropriate documentation).

4.18.3 Qualifications

Qualifications for personnel working on the Auger are based upon the responsibilities of the position and project needs, which define the level of education, extent of work experience, knowledge and specific skill requirements.

4.19 Maintenance

4.19.1 Policy

The policy of the Auger Project is to ensure that the maintenance done on the Observatory allows for it to have a lifetime of at least twenty years.

4.19.2 Specifics

Quality and reliability are designed into the Observatory. However, we also understand that entropy works to break down the detectors. This means that the Observatory will need maintenance to be able to last for at least twenty years. This maintenance must be planned appropriately so that the proper resources (man, machine, and method) can be allocated for the work.

Although input from all participants in the project is required to build an effective maintenance program, it is the responsibility of the Task Leaders to define and document a servicing/maintenance program (referred to as a "subsystem maintenance package - "SMP") for their subsystem. This package goes through peer review before it is approved and implemented. After it is approved, the Task Leader is responsible for training the Site Manager on the SMP.

It is the responsibility of the Site Manager to:

- organize a servicing/maintenance program for the Observatory using the SMP's;
- implement the servicing/maintenance program for the Observatory; and
- ensure that the site personnel receive the appropriate training on the program.

Section 7 of the Project Management Plan contains more details regarding the SMP.

4.20 Statistical Techniques

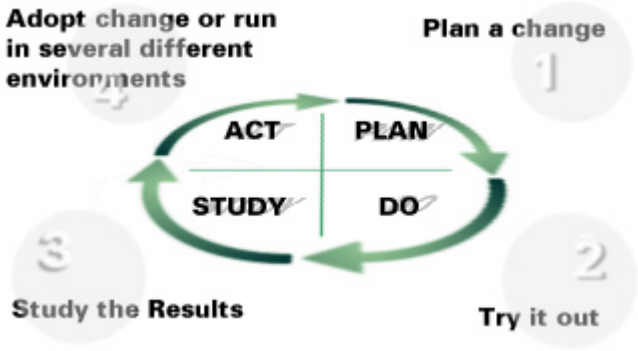
4.20.1 Policy

The policy of the Auger Project is to identify and use appropriate statistical techniques so that the quality objectives of the Project can be met.

4.20.2 Specifics

As scientists, we use statistics to analyze experimental data. Other statistical methods also allow us to improve the processes we use to fabricate the detectors (as well as any other process). Tools such as Statistical Quality Control (SQC) and Statistical Process Control (SPC) aid in determining the level of quality (on-target with minimum variance) of incoming parts and the fabrication process. They can aid in seeing a potential problem before it happens, or at least before it goes to the next step in the process. Pareto diagramming is also an excellent tool for identifying areas that need improvement.

Task Groups should make a concerted effort to utilize statistical methods to facilitate continuous improvement. The following diagram can be used as a guide for making process improvements:



Training and help with the implementation in the use of any of these tools is available from the Quality Assurance Manager.

Revision History

Version	Date	Section No.	Specifics
1	10/24/00	All	First version

Controlled Distribution

Auger Project Office

Original file location

http://tdserver1.fnal.gov/users/mc/blowers/projects/auger/QA_Plan/QA_Plan_Auger.doc

(UNC address: \\TDSERVER1\users\mc\blowers\Projects\Auger\QA_Plan\QA_Plan_Auger.doc)